Coxiella burnetii (Q fever) abortion storms in goat herds after attendance at an annual fair

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Coxiella burnetii, the etiological agent of Q fever, infects several animal species, including humans (1,2). Goats, sheep, cats, and cattle are the species most frequently infected (1–5). Infection in these species is usually subclinical, but abortions do occur in naive goats, sheep, and occasionally cattle (1–6). Infection in humans usually follows exposure to infected livestock that are shedding the organisms during parturition or abortion. Influenza-like symptoms may follow infection in humans (1,2,7). Abortion storms due to Q fever that affect several herds over a large geographical area are unusual (8). This report summarizes findings in Q fever abortions occurring in five goat herds (four in Ontario and one in New Brunswick) following exposure to parturient goats at the 1991 Royal Winter Fair (RWF) in Toronto.

Goats from all five affected herds (A-E) were present at the annual RWF in Toronto between November 3 and 9, 1991 (Table 1). All the goats were housed in the same barn during their stay at the RWF. During this time, three goats from another herd (not included in Table 1) kidded prematurely. All except one of their kids were stillborn or died soon after birth. Laboratory investigations were not conducted on any of these kids or their fetal membranes.

The first abortion occurred in herd A on December 16, 1991, 21 days after the RWF. Ultimately, reproductive failure, characterized by abortion, stillbirth, premature kidding, or weak newborn kids, occurred in 11 of 33 pregnant does in herd A (Table 1). Affected does ranged in age from one to eight years and in parities from first to seventh. Six of the 11 does had attended the RWF. Parturitions were uneventful in does that kidded more than 76 days after the RWF. Abortions started in herd B on January 1, 1992, 53 days after the RWF. Reproductive failure occurred in all 5 of 16 does that attended the RWF from this herd. Parturitions were uneventful in does kidding more than 76 days after the RWF. Seven of 15 does from herd C aborted between January 15 and March 7, 1992 (between days 67 and 118 after the RWF). All seven that aborted had attended the RWF. Five does attended the RWF from herd D. Two of these does experienced reproductive failure. Reproductive failure was recorded in three of the eight does that attended the RWF from herd E. Three of the Ontario herds were from the Niagara peninsula in southern Ontario and the other was from just outside the peninsula in southwestern Ontario. Herd C was from New Brunswick. Not all goat herds that were at the RWF were affected. For example, in three other herds represented by 29 goats at the RWF, none of the goats were affected.

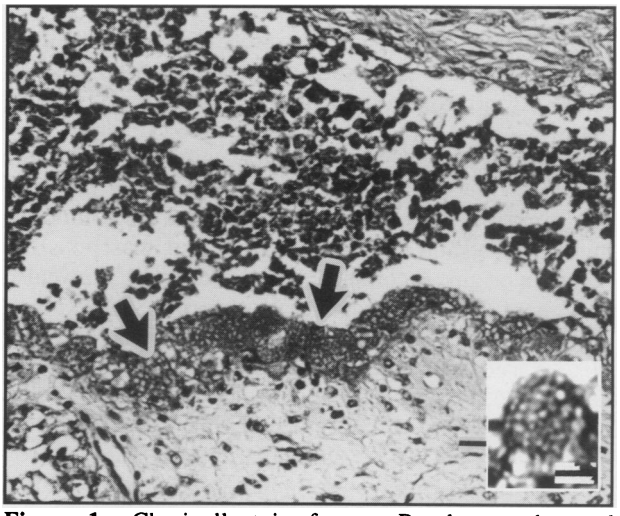

Figure 1. Chorioallantois of a goat. Purulent exudate and necrotic debris above placental surface. Note the characteristic foamy appearance of trophoblast cells infected with *Coxiella burnetii* organisms (arrows) on the chorionic surface. (Bar = 50 μm). Inset: Characteristic swollen foamy appearance of chorionic trophoblast cell infected with *Coxiella burnetii* organisms. (Bar = 5 μm).

The dams that aborted did so without premonitory signs. Uterine inertia necessitating assistance was a recurring problem experienced by the dams that aborted in four of the five herds (A, B, D, and E). The aborted fetuses had no gross lesions. However, there was one set of stillborn conjoined twin fetuses in herd A. The placentae were usually thickened and sometimes leathery, granular or gritty. The placentae frequently had a copious creamy-yellow or brownish discolored exudate that was most prominent in the intercotyledonary areas.

Aborted fetuses and/or placentae were submitted for laboratory examination from all five herds. Sera were collected from goats from all five herds, during or soon after the abortion storms, and tested for antibodies to *C. burnetii*. Sera were obtained from all breeding animals in the Ontario herds. Seven of the eight animals that attended the RWF were tested from herd C. An ELISA test (9) was used for sera from herds A and C (SANTEIA Animal Health Support, Guelph, Ontario) and either this ELISA test or an immunofluorescence test (7) was used for sera from the other three herds. Sections of representative tissues from fetuses and placentae were placed in 10% neutral buffered formalin and processed routinely for histological examination. No significant bacteria were isolated from internal fetal organs or placentae using routine bacteriological cultural techniques. Smears of the placental exudate from the first case in herd A and one case in herd C were stained with a modified Köster's stain (10) and revealed large numbers of pleomorphic,

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Table 1. Profiles of goat herds with reproductive failure after attending 1991 Royal Winter Fair (RWF)

Herds	No. of adults	No. at 1991 RWF	Reproductive failures (Aborted/ Pregnant)	Q Fever diagnosis based on: Serology	Histology	Comments
A	40	6	Yes (11/33)	34 Positive 6 Negative	Yes	
B	17	5	Yes (5/16)	11 Positive 6 Negative	Yes	
C	15	8	Yes (7/15)	4 Positive 3 Negative	Yes	7 of 8 attending the RWF aborted
D	10	5	Yes (2/5)	5 Positive 5 Negative	Yes	The 5 negatives were not at RWF
E	25	8	Yes (3/15)	20 Positive 5 Negative	Yes	

acid-fast organisms consistent with the appearance of *C. burnetii*. Microscopic lesions consisted of diffuse purulent placentitis, placental necrosis, and mineralization (Figure 1). These lesions were more pronounced in the intercotyledonary areas. Trophoblast cells were swollen and had a characteristic foamy appearance (Figure 1 and inset). Faintly acid-fast, pleomorphic organisms consistent with the appearance of *C. burnetii* were present within the cytoplasm of the trophoblast cells. Small numbers of mononuclear inflammatory cells were occasionally seen in fetal livers, at the corticomedullary junction of kidneys, and near bronchioles in the lungs. Results of serological tests for antibodies to *C. burnetii* are shown in Table 1.

The diagnosis of Q fever abortions was confirmed in all five herds by observation of typical placental lesions and identification of the characteristic *C. burnetii* organisms in trophoblast cells. This was supported by high antibody titers to *C. burnetii* in sera from most breeding animals in the five affected herds. For the most part, the goats that aborted were in early gestation during their attendance at the RWF. Those animals that kidded in mid and late spring (and therefore were not pregnant at the time of the RWF) were usually unaffected and delivered normal offspring. Abortion due to *C. burnetii* infection usually occurs late in gestation (8,11), possibly because multiplication of the organism is delayed until the very late stages of pregnancy (8). Abortions started in herd A 21 days after the RWF. Most of the abortions in the other four herds occurred from about 50 to 120 days after the RWF. The does that aborted were all in late gestation.

The fetal membranes and fluids, even from the normal parturitions, were most likely infected with organisms and a potential source for the zoonotic spread of Q fever. In addition to the epizootic abortions in the goat herds investigated here, several people also contracted Q fever (6,7, and Steeves A, personal communication, 1993). All of these people had contact with one or more of these herds, or were in contact with the parturient goats at the 1991 RWF.

This is the first reported epizootic of Q fever abortions in goats that has been traceable to a single source of exposure in Canada. Most reports in Canada and elsewhere have dealt with sporadic abortions (3,4,5) rather than epizootic outbreaks (8). The initial source of the epizootic was almost certainly exposure of goats to aerosolized organisms from the aborting goats at the 1991 RWF. Those aborted fetuses and membranes were never subjected to diagnostic tests. The herd owner has been uncooperative, so the aborting goats have also never been tested. Absence of abortion in previous years followed by abortions due to Q fever in several herds and subsequent Q fever outbreaks in several people, supplies strong circumstantial evidence for an initial single point exposure occurring at the RWF.

Q fever in humans is treatable with tetracycline (1,2) but there is no practical method of treatment for farm animals (1,4). Nevertheless, each breeding animal in three of the Ontario herds (B, D, and E) was given 125 mg of chlortetracycline (Aureomycin vitamin premix crumbles, Cyanamid, Willowdale, Ontario) in the feed daily, for up to 120 days, in the hope of preventing the continued shedding of infectious organisms during and immediately after the kidding season of 1992. The efficacy of this treatment is debatable, but it was enthusiastically embraced by the producers who felt committed to some course of action when confronted with the zoonotic outbreaks around them. A formalin-inactivated Q fever vaccine is effective in cattle (1,4) but is not available commercially in North America. The vaccine protects against abortion but not infection and has not been proven in other animals or humans. Prevention of zoonotic spread is therefore still best accomplished by:

1. Isolating aborting does for up to 14 days.
2. Raising feedbunks to prevent contamination of feed by excreta (organisms can be shed in feces and urine).
3. Destroying aborted materials, eg, by burning and burying fetal membranes and dead kids.
4. Wearing masks and gloves when handling aborted materials.

Abortions usually occur when naive animals are infected with *C. burnetii* during pregnancy. It would, therefore, be expected that these herds should have no problems with Q fever abortions in future gestations.

Additions of naive animals to the herds or a rapid turnover of the existing breeding herd, however, would result in a new susceptible population subject to similar outbreaks. All herds have had normal reproductive performances in the 1993 kidding season. The policy of showing animals in late stages of gestation at fairs and livestock shows may have to be re-examined, considering the potential for recurrence of similar outbreaks.

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